But when you wind the clock, you relieve the great wheel from the strain of the weight, and the clock would stop if you did not introduce mechanism to prevent it. Fig. 6 represents such mechanism.

In this case the click L is fastened not upon the great wheel G G but upon an additional ratchet-wheel, $R_2 R_2$, which rides loosely upon the axis of the great wheel. Its

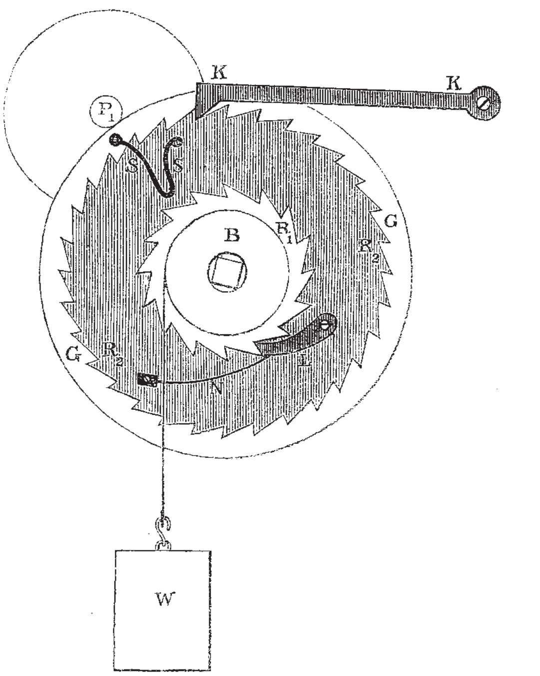


Fig. 6.

teeth, which point in the reverse direction to those of the first ratchet-wheel, pass under the long click K K mounted within the clock frame, and so far as the driving power of the clock weight is concerned, its action may be neglected altogether.

This ratchet-wheel is connected with the great wheel only by the spring S S, one end of the spring being fastened to the great wheel and the other to the ratchet-wheel. The strain of the clock weight keeps this spring closed and is transmitted to the great wheel through it.

Let us see what will happen when we try to wind. The spring S S is relieved from the strain of the weight and essays to open by thrusting back the ratchet $R_2 R_2$, but this it cannot do, for the long click K K prevents it, and banking against this the thrust of the spring is transferred to the clock-train.

Other mechanism is also employed for the purpose.

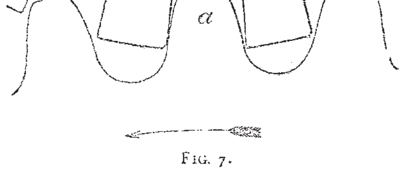


Fig. 7.

One very favourite plan (a very old one, which has been once or twice re-invented lately) places the fulcrum of the lever (in other words, the spindle of the wheel) through which the barrel is wound, upon the great wheel itself.

Great care has to be taken both in shaping and sizeing the various wheels and pinions. It is an advantage to have high numbered pinions, because in this case you do not get so oblique an action of the wheel teeth upon the teeth of the pinions : the action is more across the line of centres.

The curves of the teeth must also be properly formed. The broad principle is to get an uniform running, that is, that the pinion shall always move at a fixed and definite rate with regard to wheel, for if it moves faster or slower it is quite clear that the wheel tooth is acting too far up or too low down the flank of the pinion tooth, that is to say, working it at the end of too short or too long a lever ; and less or more power is accordingly transmitted. If you look at Fig. 7 you will see easily that if the top of the wheel tooth *a* were not rounded off quite so much it (supposing the present curve correct) must drive the pinion too fast, and too little power would then be delivered.

Sometimes the main clock-train is merely employed to wind up at certain short intervals (usually twice a minute) a subsidiary weight or mainspring, which latter is that which immediately propels the escape wheel. In this manner variations in the friction of the clock-train can

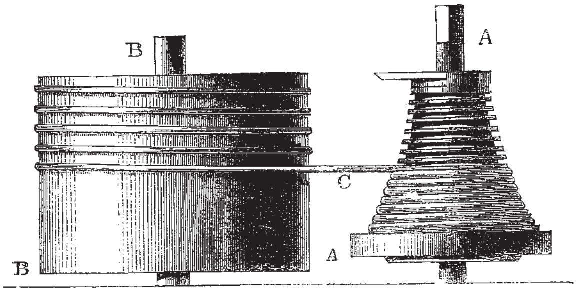


Fig. 8.

be in great measure prevented from reaching the pendulum, if there is a little less or more power upon the clock-train, the only effect being to wind up the subsidiary weight or spring more or less rapidly. The main clock-train is at the right moment liberated by some mechanism upon the spindle of the escape-wheel and the minute-hand being connected with it moves by jumps whenever the weight or spring is wound up.

The general arrangement of the train of watches and chronometers differs little from that of clocks, but the power is delivered by means of a coiled spring, which necessitates the following arrangement.

The spring pulls harder the further you wind it, and its force at commencing would be obviously greater than when it has in part run down ; we therefore introduce the following compensation (see Fig. 8). We place the great wheel upon that hollow-sided cone or "fusee" A A, and connect it with the barrel B B (which is impelled by the main spring inside it) by means of a chain, C. When the spring pulls hardest it has the thinner part of the fusee to act upon, it works a lever of shorter radius, and the force at the circumference of the great wheel is in this manner equalised.

(*To be continued.*)

FLORIDA SHELL MOUNDS[1]

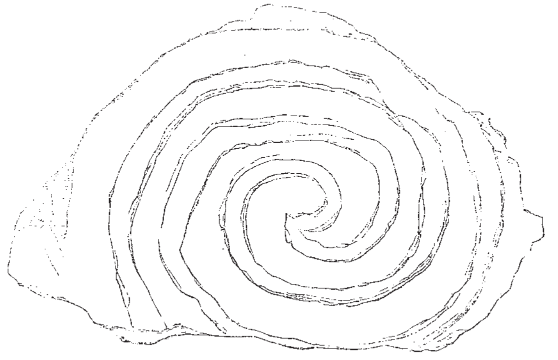
THE river St. John drains the eastern portion of the northern half of the peninsula of Florida, running northward over a flat country for a distance of about 300 miles. In the lower part of its course it opens out into large sheets of water two to three miles in width, and as might be expected from the nature of the country, it frequently shifts its bed, and is liable to annual inun-

[1] Fresh-water Shell Mounds of the St. John's River, Florida. By Prof. Jeffries Wyman. In the Memoirs of the Peabody Academy of Science. Vol. I. No. 4.

dations which place large tracts of the surrounding country under water; indeed it is said that a depression of ten feet would cover the whole of this part of Florida by the sea.

It is not until the river begins to narrow its channel near Palatka that the shell mounds which form the subject of this memoir begin to appear, and they then continue at intervals along the banks of the river as far south as Salt Lake. They always are, or have been at one time, on the river bank, although the latter has in some places removed from them, and in others encroached so as to totally destroy or cut deeply into their sides, and as is frequently found to be the case with prehistoric fishing habitations elsewhere, the junction of the river with the lagoons was often selected as a place of residence. Most of the mounds are in the form of ridges parallel to the shore, fifteen, twenty, or twenty-five feet in height, flat-topped, and some of them covering several acres of ground; others are circular; and others again form shell-fields having their materials more evenly distributed, and not more than two to three feet in thickness.

They are composed almost entirely of fresh-water shells of three species, viz., *Ampullaria depressa*, Say; *Paludina multilineata*, Say; and *Unio buckleyi*, Lea. Of these the paludina forms by far the largest portion of every mound, and with a few unios the whole of some, but deposits of either of the above species are occasionally found alone instead of being promiscuously mixed



with the others, showing that probably at certain times they had been used exclusively for food. All three species are now found inhabiting the rivers and creeks, and more particularly the lagoons, the bottoms of which are sometimes covered with them, and yet they are not now found in such abundance as to suffice for the creation of such large mounds, from which it must be inferred either that the construction of the mounds must have been spread over a long period of time, or what is equally probable from the known habits of shell-fish, that they must have existed in greater abundance formerly. It was also noticed that the *ampullariæ* and *paludinæ* in some of the shell mounds were much larger than their living representatives. These observations remind us of similar changes which have been noticed as having place in the size and distribution of the shell-fish found in the kitchen middens of Denmark.

The mounds consist solely of refuse heaps of food, and were not thrown up for any other purpose, which is proved by finding hearth-stones with charcoal, and the remains of the bones of animals used for food at different levels throughout the mass. The animal remains consist of the following species, viz.:—bear, raccoon, hare, deer, otter, opossum, turkey, alligator, hard and soft-shelled turtle, box-turtle, gopher, catfish, gar-pike, whiting, and other birds and fish not determinal. No trace of domesticated animals has been discovered, nor does the dog anywhere appear in the shell mounds, and there is no evidence that agriculture had been introduced. A few bones of mastodon, horse, ox, and other animals now extinct in this region have been found, but their condition has led the author to think it certain that they do not belong to the age of the mounds, and may perhaps have been scooped up from the bottoms of the creeks with the shells taken for food. Fragments of human bones found scattered here and there in the mounds, and broken up in the same manner as the bones of edible animals, lead to the inference that the constructors of the shell-heaps were cannibals, which is rendered all the more probable by the known prevalence of this custom throughout the two continents of America.

Only one skull of the builders has been found; this differs from the skulls of the burial-mounds in being longer, with the ridges and processes more pronounced, but does not afford sufficient data for forming any opinion as to the physical peculiarities of the race. Platycnemism has been found to exist in several of the bones here, as well as in skeletons from Kentucky, Labrador, Michigan, and California, but the author's researches on this point lead him to think that this peculiarity cannot be considered as forming a race-character amongst the Indians, as it exists also amongst the white race, several sections of the tibias of whom, by the side of those of Indians, are given in the work.

Amongst the relics of human industry discovered in the mounds, stone implements are rare and generally of rude form, consisting of chips, flakes, stone hammers, and a few implements resembling the drift types of Europe, which last may, however, have been unfinished specimens. Arrow-heads of four or five different forms are described, viz. (1), triangular with a straight base, (2) triangular with a notched base, (3) with a stem or tang, and (4) triangular with notched sides; also a few rude leaf-shaped implements, which may have been used for this purpose. Unfortunately, illustrations of these are not given, but it may be observed that the triangular arrow-head with side notches is a form which is almost exclusively confined to America, being common throughout the United States and in Patagonia. The bone tools consist chiefly of awls, the ulna of the deer being a favourite bone for this purpose; fragments of stag's horn are also found cut round the outside and broken off, and also with longitudinal incisions for the purpose of detaching long pieces suitable for making pins.

The shell tools are made exclusively of marine species, viz., the *Strombus gigas*, and two species of *Busycon*, found abundantly on the Atlantic and Gulf coasts, and known to have been used in prehistoric trade as far north as the great lakes. They appear to have been held in the hand, and are spoken of by Le Moyne and Cabeza de Vaca as implements employed by the Indians for cutting wood.

Pottery is found only in the later mounds in small fragments and is composed of clay mixed with a vegetable fibre; the vessels were all hand-made, and appear to have been formed in irregular curves and of uneven thickness, generally flaring at the mouth, and sometimes ornamented with incised lines. One fragment, of which an illustration is given, appears to deserve more attention than is given to it in the memoir. It is ornamented with a loop-coil clearly but rudely traced, forming a fragment perhaps of the class of ornament known in architecture as the Vitruvian scroll. The distribution of the use of this ornament occupies, so far as we have been able to trace it, a continuous geographical area. It is common in Peru, Mexico, Colorado, Arizona, and amongst some of the tribes of the northern part of South America, and its occurrence here is of interest, as affording perhaps the most reliable evidence of connection with the arts of the races to the south and westward.

Like the kitchen middens of Denmark, these shell-heaps were, for many years after their discovery, con-

sidered to be of natural origin. Little or no notice of their contents appears to have been taken until the examination of them by Prof. Wyman, in 1860 and 1867. They are now for the most part covered by a thick forest-growth, the chief trees being oaks and palmettoes, with many shrubs and vines. The age of some of the oaks growing upon the mounds has been estimated by their annual rings at 400 years, and one, a gigantic one, at 666 years. Taking this into consideration, together with the changes in the channel of the river, the formation of new land, and the extension of plants and trees over it, Prof. Wyman thinks that an antiquity of a thousand years would not be an unreasonable age to allow for the earliest shell-mounds.

OUR ASTRONOMICAL COLUMN

THE VARIABLE STAR 34 CYGNI, NOVA 1600.—This star, although an object of pretty frequent meridian observation, has probably received less attention than most others from those observers who especially occupy themselves with the variable stars, owing to the circumstance of the estimates of magnitude recorded at transit having been remarkably accordant for upwards of a century. Indeed since the year 1750, on examining the catalogues, we find in the majority of cases that the star is estimated $5\frac{1}{2}$, the only marked exception being Bessel's observation in his zone 1825, September 14, when it is called 6·7.

If, however, we examine the earlier history of this star, we see there are some grounds for suspecting that one or more maxima may have escaped observation, unless the irregularity of variation attributed to it, in the recent catalogues of such objects be very great.

The discovery of the star is ascribed to William Janson, who had marked it on a celestial globe in 1600, as we learn from Kepler ("De Stellâ tertii honoris in Cygno," appended to his well-known work, "De Stellâ novâ in pede Serpentarii," which appeared in 1606). Kepler himself was not aware of its existence till May, 1602, and he enters into an explanation which is, to an extent, apologetical, for his not having previously remarked it. At the same time he calls it a *new* star, and in proof of its being so, adduces, in addition to Janson, the authority of Justin Byrgius and Bayer, who, by the way, has attached the letter P to the star in his "Uranometria," and is followed by Prof. Schönfeld. By observations in August, 1602, he fixed its position in R.A. 300° 46′, Decl. 36° 52′, which agrees closely with the modern catalogues. He calls it a third magnitude in 1602, and states that it continued of the same brightness during the nineteen years over which his observations extended; it was not quite so bright as γ Cygni, but was brighter than β in the same constellation.

According to Liceti it appeared again in 1621, afterwards diminishing, until lost altogether. In 1655 it was observed again by Dominique Cassini, and gradually brightened during five years, until it attained the third magnitude, and subsequently diminished. Hevelius states that it reappeared in November, 1655; it was still very small in 1666, afterwards becoming brighter, though without reaching the third magnitude. In 1677, 1682, and in 1715 it was estimated a sixth magnitude, and there is no further record of its increase to the maximum of 1602.

Pigott assigned a period of eighteen years, which but imperfectly represents the observations of the seventeenth century.

Schönfeld remarks that it is doubtful whether the star had its actual brightness before the year 1600, or was invisible; perhaps the former condition will be considered the more probable, notwithstanding Kepler's account of its having escaped his observation from the year 1591, when he commenced the study of the heavens under Mæstlin, and noted but one conspicuous star in the breast of the Swan.

Probably a systematic observation of 34 Cygni may lead to the record of another maximum. The star is of a deep yellow colour, and its position for the beginning of 1877 is in R.A. 20h. 13m. 15s., N.P.D. 52° 21′.

Its neighbour χ (Bayer) Cygni, deserves special attention at present, the fluctuations of brightness for some years past having been quite exceptional. Its position is in R.A. 19h. 45m. 50s., N.P.D. 57° 23′ for 1877·0.

THE INTRA-MERCURIAL PLANET QUESTION.—M. Leverrier made a further communication to the Paris Academy, on the 2nd inst., with reference to this subject. Having collected in his previous communications, chiefly from the original authorities, such observations as could be supposed to bear upon it in any way, he finally selects for discussion those only which, in addition to the roundness and blackness of the spots, have distinct mention of sensible change of position upon the sun's disk on the day of observation. There are ten cases under this head in the months of January, February, March, May, and June, or possibly beginning of July, and October. M. Leverrier remarks it is inadmissible that a body projected upon the sun on February 12, which is the date of the observation by Steinheibel mentioned in the correspondence between Olbers and Bessel, could repass at the end of March or beginning of October, *i.e.*, when arriving in the line of nodes of the objects seen by Lescarbault and Lummis. This could only happen if the first body moved in an orbit very little inclined to the ecliptic, but in this case the necessary frequency of the transits must have led to its being more often observed. For the present, therefore, he confines himself to treating five observations in October and March, where motion like that of a planet in transit are recorded. His data stand thus:—

Decuppis,	1839, Oct.	2·0	... ...	Helioc. long.,	8°·60
Fritsch,	1802, Oct.	10·0	... ...	,,	16·46
Sidebotham,	1849, March	12·18	... ...	,,	172·01
Lummis,	1862, March	19·87	... ...	,,	179·86
Lescarbault,	1859, March	26·22	... ...	,,	186·60

And it is found that these five longitudes are represented with all the precision permitted by the nature of the observations by the formula (ν = helioc. longitude)—

$$\nu = 121°·49 + 10°·9017834\, j - 0°·52 \cos. \nu,$$

j being reckoned in days from 1750·0.

The differences between calculation and observation are:—

1839	...	+ 3°·6	1849	...	+ 3°·5
1802	...	− 3·6	1862	...	+ 0·8
			1859	...	− 4·6

None of the residuals exceeding a half-day's motion, M. Leverrier thinks it permissible to infer that the five observations appertain to the transits of the same body.

With the above motion the period of revolution is 33·0225 days, and the semi-axis major 0·201.

The existence of an intra-Mercurial body announced by theory, being, according to M. Leverrier, beyond doubt; to use his own words, "nous voilà desormais en possession de données permettant dès à present de constituer une première théorie qui conduira à retrouver la planète avec facilité et à la faire rentrer dans le système régulier des corps célestes." In conclusion he states that he is now occupied in determining the epochs of the next following transits over the sun's disk.

NOTE ON THE SUN-SPOT OF APRIL 4, 1876

(Communicated by the Astronomer Royal)

ON the publication of Herr Weber's observation of a round spot seen on the sun on April 4, reference was made to the photographs taken at the Royal Observatory, Greenwich, on the morning of that day, and it was remarked at once that there was a small round spot